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Possibilities of the All Purpose Tractor

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ALTHOUGH the purpose of this article is to show some of the possibilities of an all-purpose tractor on a corn belt farm, it is not intended as a reflection on the efficiency or the increased use of the present type of tractor.

The four-wheeled tractor, as at present built, shows its efficiency best in the work of producing small grain. A study of the tractors in the United States, as reported by the 1920 census, shows that in spite of this the six leading corn producing states, Iowa, Illinois, Indiana, Ohio, Nebraska and Missouri, have a total of 82,060 tractors. This is approximately one-third of all the tractors in the United States.

The time-saving advantages of the present type of tractor in getting the work done at the proper time and coping with the uncertainty of the weather is apparent enough to even the corn belt farmer, so that they buy them and use them in quite large quantities.

The possible market for tractors, however, in the corn belt, has hardly been scratched, for study reveals that only about 6 per cent of the farms in these six states have tractors, while the other 94 per cent still depend on horses for power.

The reason for this is very apparent to anyone who has made a study of the tractor situation. Unless the farmer has a large farm, where it is absolutely necessary to do the work faster than horses can do it, or if he has certain belt work considerations, whenever the subject of the purchase of a tractor is brought up, he will usually reply, "I have to have enough horses for cultivating my corn, and this is nearly enough to get all of my work done." In other words, he cannot replace enough horses to make it an economical proposition.

The logical solution, then, is to design a tractor that will do cultivating as well as plowing, disking, dragging, and other drawbar work.

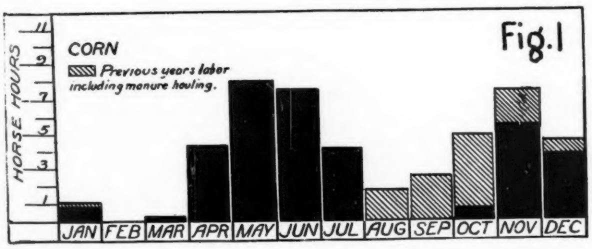
That may seem simple, but in actual practice it is not. Plowing is a heavy job and requires considerable power. For dependability and long life the tractor must be built fairly strong and heavy. A two-plow job requires from eight to nine drawbar horsepower and weighs in the neighborhood of 3000 pounds. A three-plow job requires from 12 to 13 drawbar horsepower and weighs 4500 pounds, or more.

Cultivating requires a light, fairly quick moving tractor —one that will not pack the soil and will handle easily enough so that most of the driver's attention can be given to the cultivator itself. It must have a very short turning radius, so that it can turn at the ends and not run over the corn. At the most, it does not require over 4 or 5 drawbar horsepower to pull a double-row cultivator. It is desirable to keep the weight down, if possible, to 2000 pounds.

These two varying power requirements cannot be fully met in any one tractor. A happy medium, however, can be designed. This happy medium would have a drawbar horsepower from 6 to 7, and weigh not to exceed 2800 to 3000 pounds. Such a tractor would pull two 12-inch plows under ordinary conditions and a 16-inch plow under practically all conditions. It would easily operate a two-row cultivator.

To secure maximum efficiency, it should also be designed to operate from the seat of the implement and to hitch to any standard horse-drawn tool with only minor changes in the tool itself.

One man with such a tractor, traveling at 2½ miles per



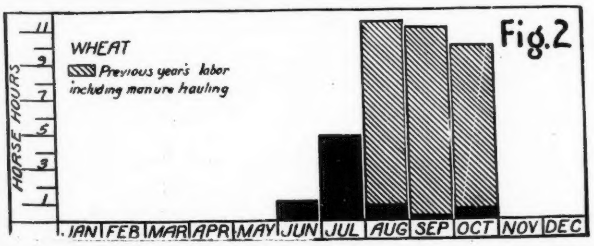
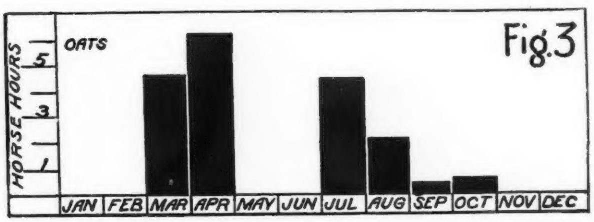


Fig. 1. Total horse hours, 46.1. Fig. 2. Total horse hours, 38.1



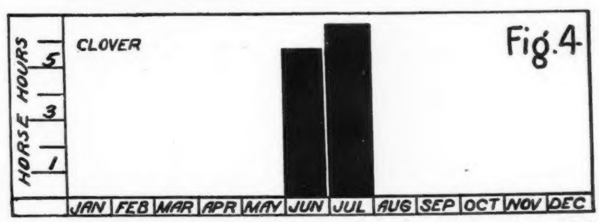


Fig. 3. Total horse hours, 18.3. Fig. 4. Total horse hours, 12.0

TABLE I. DIVISION OF WORK BETWEEN HORSES AND FOUR-WHEEL TRACTOR

Month	Corn Tractor	Corn Horses	Oats Tractor	Oats Horses	Winter Wheat Tractor	Winter Wheat Horses	Clover Tractor	Clover Horses
January	....	80 hrs. hauling manure	....	....	....	....	....	....
February	....	....	....	....	....	....	....	....
March	40 hrs. plowing	....	180 hrs. disking	....	....	....	....	....
April	360 hrs. plowing and disking	....	160 hrs. disking	100 hrs. drilling	....	....	....	....
May	380 hrs. disking and dragging	240 hrs. planting 120 hrs. cultivating	....	....	....	....	....	....
June	....	600 hrs. cultivating	....	....	....	10 hrs. harvesting	....	110 hrs. harvesting
July	....	320 hrs. cultivating	....	170 hrs. harvesting	....	200 hrs. harvesting	....	130 hrs. harvesting
August	140 hrs. plowing previous year	....	....	90 hrs. threshing	420 hrs. plowing previous year	30 hrs. threshing	....	....
September	200 hrs. plowing previous year	....	....	20 hrs. hauling	120 hrs. plowing previous year	20 hrs. hauling	....	....
October	3[illegible]0 hrs. plowing previous year	70 hrs. husking	....	30 hrs. hauling	360 hrs. plowing previous year	40 hrs. hauling	....	....
November	160 hrs. plowing previous year	440 hrs. husking	....	....	....	....	....	....
December	80 hrs. plowing previous year	280 hrs. husking	....	....	....	....	....	....
Total Horse Hours	1690	2150	340	410	1200	330	....	240

hour, and with the equipment mentioned below, could easily accomplish the following work per day:

16-inch plow	3 ¾ acres
6-foot disk	15 acres
16-foot harrow	40 acres
Single-row corn planter	12 acres
Double-row corn cultivator	14 acres
6-foot drill	15 acres
8-foot drill	18 acres
6-foot mower	12 acres

Except in planting and cultivating, where it is doubtful if greater speed would be desired, one could accomplish about 25 per cent more work per day with a tractor than with horses, with the same implement.

In addition, such a tractor would displace about 50 per cent or more of the horses at present used on the corn belt farms. This is shown by a study of the work required for various corn belt crops, as reported in the University of Illinois Bulletin No. 231. This bulletin reports the horse work in terms of horse hours, which means the number of hours one horse would require to do the work.

Figs. 1, 2, 3 and 4 are taken directly from this bulletin and show the horse hours required per acre for producing corn, winter wheat, oats and clover. Fig. 5 shows the total horse hours required per year on a farm of 200 crop acres with 80 acres of corn, 40 acres of oats, 40 acres of winter wheat, 20 acres of clover hay, and 20 acres of clover pasture.

Unfortunately the bulletin does not report the division of the work, so that the writer had to draw on his own knowledge of farm conditions to determine just what part of the work was plowing, disking, dragging, cultivating, etc., and all of the figures given in the tables are approximations.

Of the 6360 horse hours of work on the crops on this farm, a four-wheeled tractor is capable of doing 3230 hours, leaving 3130 for the horses. The main drawback to the tractor, however, is that the division of the work is not equally divided throughout the year. The work in July and August, which are two of the heaviest months in the year, is cultivating, harvesting, etc., which the tractor is not very well fitted to do. The result is, not very many horses can be displaced at this time of the year. Table I below shows the approximate division of the work between the horses and tractors on the four crops in question.

The all-purpose tractor, however, would be able to do the equivalent of 4870 horse hours, leaving only 1390 horse hours for horses. Study also shows that the peak load on the horses would be changed from July and August, or the cultivating season, to the corn husking time. During corn husking on a farm of this size, it usually requires the time of two more horses. Otherwise the tractor and two horses could do all the work.

On account of the four horses needed during corn husking, in actual farming operations the tractor would not be called

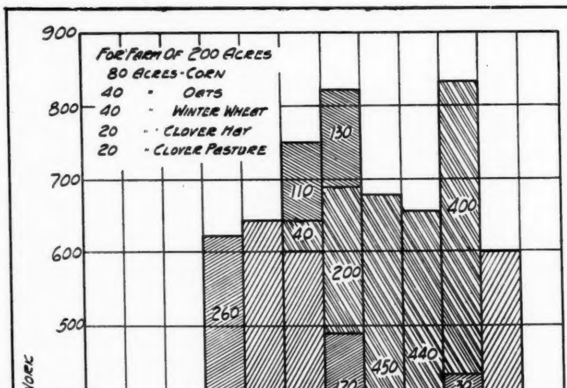


Fig. 5. Chart of horse labor hours compiled from Illinois Bulletin No. 231

TABLE II. DIVISION OF WORK BETWEEN HORSES AND ALL-PURPOSE TRACTOR

Month	Corn Tractor	Corn Horses	Oats Tractor	Oats Horses	Winter Wheat Tractor	Winter Wheat Horses	Clover Tractor	Clover Horses
January	....	80 hrs. hauling manure	....	....	....	....	....	....
February	....	....	....	....	....	....	....	....
March	40 hrs. plowing	....	180 hrs. disking	....	....	....	....	....
April	[illegible]60 hrs. disking	....	210 hrs. disking, etc.	50 hrs. drilling	....	....	....	....
May	640 hrs. disking planting cultivating	....	....	....	....	....	....	....
June	600 hrs. cultivating	....	....	....	40 hrs. harvesting	....	....	110 hrs harvesting
July	320 hrs. cultivating	....	170 hrs. harvesting	....	200 hrs. harvesting	....	....	130 hrs. harvesting
August	140 hrs. plowing previous year	....	....	90 hrs. threshing	[illegible]20 hrs. plowing previous year	[illegible]0 hrs. threshing	....	....
September	200 hrs. plowing previous year	....	....	20 hrs. hauling	20 hrs. plowing previous year	20 hrs. hauling	....	....
October	350 hrs. plowing previous year	70 hrs. husking	....	[illegible]0 hrs. hauling	[illegible]60 hrs. plowing previous year	40 hrs. hauling	....	....
November	160 hrs. plowing previous year	140 hrs. husking	....	....	....	....	....	....
December	80 hrs. plowing previous year	280 hrs. husking	....	....	....	....	....	....
Total Horse Hours	2870	870	560	190	1440	90	....	240

upon to do as much work as it is capable of doing or as much as Table II shows. Both horses and tractors would be worked to their maximum capacity at practically all seasons of the year to secure the greatest economy of horses, machinery, and men. Table II shows the maximum possibilities of the all-purpose tractor.

Fig. 6 visualizes clearly the amount of horse hours that a four-wheeled tractor would displace on this 200-acre farm.

Fig. 7 in turn visualizes the number of horse hours that it is possible for an all-purpose tractor to displace.

If the capacity of this small tractor would be sufficient to get the work done on time, it would be the logical power solution for smaller corn belt farms and an auxiliary to the large tractor on the larger farms.

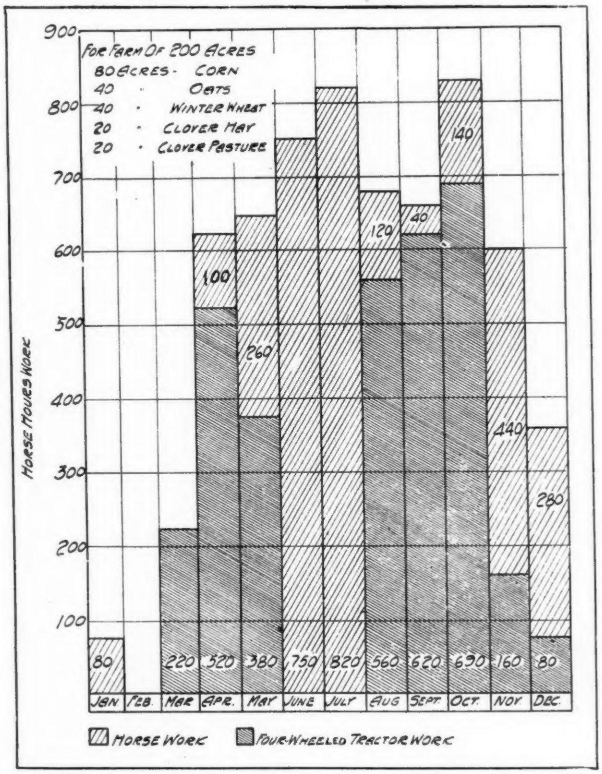


Fig. 6. Comparison of horse and four-wheeled tractor labor converted to horse hours

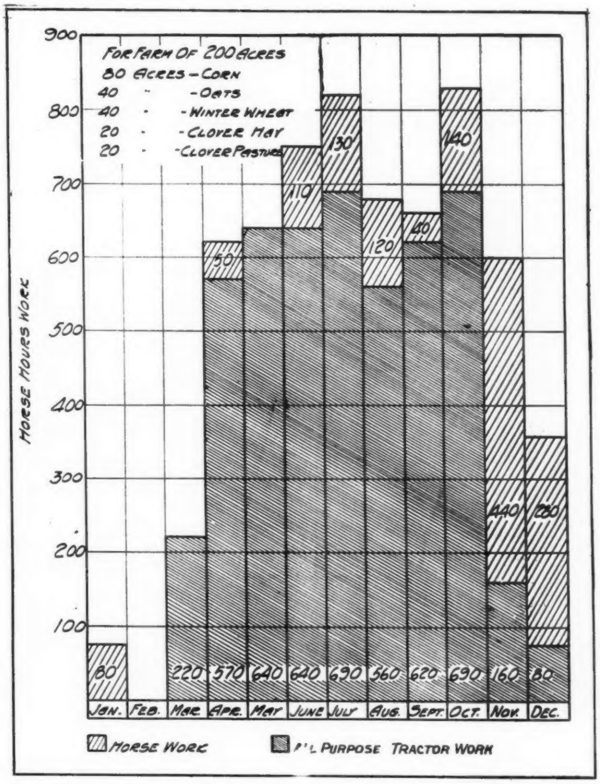


Fig. 7. Comparison of horse and all-purpose tractor labor converted to horse hours

Factors Influencing the Design and Operation of Farm Building Ventilation Systems*

By M. A. R. Kelley
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THE object of these investigations was to determine the factors which influence the operation and design of farm building ventilating systems. The tests were conducted in cooperation with various members of the A. S. A. E. Committee on Farm Building Ventilation and several state agricultural experiment stations.The ventilation of barns is an important consideration in the maintenance of the health of stock and in the preservation of hay and grain and barn timbers. It is of particular interest to agricultural engineers, since it is a large factor affecting the economic construction of farm buildings.

The tests were started during the early part of December, 1920, and continued through most of February, 1921. The first seven tests were made during December; eight during January, and the last four in February. Altogether nineteen tests were made; three in horse barns, one in a hog house, two in barns with mixed stock, and the remainder in dairy barns. Five tests were made in North Dakota, six in Minnesota, one in South Dakota, three in the upper and two in the lower peninsula of Michigan, and two in Massachusetts.

With one exception, that of the fan system tested in South Dakota reported in the October 1921 issue of AGRICULTURAL ENGINEERING, all tests were made on systems involving the principles of the King system of ventilation and its various modifications. Three tests were made in barns using windows for intake, that is, the Sheringham valve principle. Most of the barns were of frame construction with varying degrees of insulation. Two tests were made in barns with concrete block walls, one in a hollow-tile barn, and two in barns part frame and part masonry. The influence of the different methods of construction will be discussed in the complete report of the tests.

The stock involved in these tests were two colts averageing 750 pounds in weight, 46 horses averaging 1320 pounds, 439 cows averaging 1160 pounds each, 77 head of young stock averaging 670 pounds, and 63 calves averaging 156 pounds. The average weight of the horses is very nearly the average (1350 pounds) for horses found on farms in the United States in 1920.

A definite relation between the velocity of the wind and the effect which it has in the production of draft in a well-designed ventilating system has not as yet been established. The relation between the wind pressure due to impact and that to suctional effect may be computed theoretically from formulas found in textbooks on ventilation. The draft due to direct pressure is stronger than that due to suction under like wind velocities. This relation was noted especially in barns using window intakes. In barns using wall intakes, it was noted that the wind sometimes had greater effect upon the air going out than upon that coming in.

The velocity of the wind is quite variable and in designing a system of ventilation it should not be depended upon for assistance. However, in some sections of the country the wind velocities are so high that some provision for guarding against their effect is desirable. In one test the wind variation during 48 hours ranged from no movement to 40 miles per hour. Such variations are not common and during the tests of 16 barns in only three was the average velocity more than 8½ miles per hour, as will be seen by reference to the summary table. We have reasons to believe that the wind produces little, if any, suctional effect upon the ventilation when the velocity is below 3 miles per hour, and hence, during a great part of the time, the wind will be ineffective.

In some of the tests made the relation between the wind and the amount of ventilation secured is clearly shown while in others, because of complications due to other factors, principally temperatures, its effect could not be so easily traced. Although sufficient data is not available to establish a definite relation between wind and air circulation, we can anticipate a solution to this problem in the near future. When this relation is once established a long step toward the securing of a reasonable automatic system will have been made.

It is natural to expect that the velocity of the air through the intakes most exposed to the wind will be greatest. In some barns tested the velocity of the air through the intakes on the windward side was four times that on the leeward side. As the wind increases the velocity of the air coming in on the leeward side gradually decreases and if the wind is high enough, backdrafting may occur through these intakes. This condition is commonly experienced around corners and where milk houses, silos or other nearby buildings deflect the currents of air. When whirls are formed the air sometimes goes in and sometimes out, and this reversal of air currents may take place in less than half a minute. The design and position of the intakes have influence on backdrafting, and the velocity at which the backdrafting occurs. The lowest wind velocity which produced backdrafting in wall intakes, 5 feet or more in length, was 6 miles per hour. Backdrafting in window intakes at a wind velocity of 3 miles per hour was not uncommon and in one instance occurred at a velocity of less than 1 mile per hour. In one barn backdrafting occurred in a wall intake which was not close to the corner, and with a wind blowing from the opposite side at a velocity of 16 miles per hour.

The limits of ventilation secured by the use of window intakes are clearly shown by data secured in this series of ventilation tests. However, the fact that the limitations of windows as intakes are not widely known is made evident by their frequent occurrence in places not suitable to their use. Under unfavorable conditions windows cannot be kept open sufficiently to provide ample ventilation without harmful effect. It is obviously impossible to supply sufficient fresh air in remote sections of the barn without permitting a disagreeable draft chilling the animals near the windows. It is difficult to control the amount of ventilation when the wind direction varies and frequent adjustment of windows is necessary. In other words, no reliance can be placed upon window ventilation.

It is also difficult to control the temperature in the stable when window intakes are used. When wall intake ducts are

*Summary report of Committee on Farm Building Ventilation on tests conducted during the winter of 1920-21, presented at the fifteenth annual meeting of the American Society of Agricultural Engineers, Chicago, December, 1921.

provided the windows can be kept closed, the sashes fitted tightly in the frames and storm windows provided for barns in cold climates. When window intakes are used this means of controlling the stable temperature cannot be employed without restricting the amount of ventilation. When the cold incoming air passes over the sash it cools the panes of glass and the warm moist air coming in contact with the cold glass condenses and with low temperatures forms a frost. When the temperature is just enough to cause condensation, but not frost, water runs down the sash, rusts the hinges at the bottom, if they are used, and rots the sills and frames.

The velocity of the wind has a greater influence on the amount of ventilation in barns having window intakes than in those with wall intakes. Sometimes this is beneficial but, as a rule, it prevents the uniform regulation of the ventilation. Backdrafting in window intakes occurs at much lower wind velocities; in fact, instances have been noted where this occurred with no wind blowing. It was noted that at times the volume of air passing outward through the windows was more than twice that through the regular outlets. This was especially true during periods of high wind velocity. The air is apt to come in at a high velocity on the windward side and, practically unchecked, to pass out on the leeward side. Such action is not desirable especially during cold weather. The motive power furnished by the difference in temperatures of the inside and the outside air, in a well-designed system, is sufficient in cool weather to induce ample circulation without the aid of a strong wind.

It is not the intention to imply that ventilation through window openings is impossible, nor to advise against their use in mild weather, or in southern zones. They can be used when the outside temperature is above freezing and when the circulation of a large quantity of air does not cause harmful drafts on the animals. The use of windows should be restricted during cold weather.

A study of the temperature factors is of great importance in the design of a successful ventilation system. The draft introduced by the difference in temperatures of inside and outside air is the largest single motive power producing a circulation of air. Comfort to the animals must be considered as well as the purity of the air.

The heat of animals must not only warm the stable, but also be of such a quantity that part of it may be lost in inducing the circulation of air without lowering the temperature of the barn to an uncomfortable degree. The production of heat is fairly definite, within certain limits, as will be discussed later. Hence, it will be necessary to study the means which will enable us to economically conserve the heat generated. Obviously the temperature which can be maintained in the barn is dependent upon two main factors—the heat produced and the heat conserved, and each of these in turn depends upon a number of conditions. Briefly, the maintenance of a desired temperature involves a study of the following questions: (1) insulation, which can be economically used consistently with the difference in temperature which we may expect in the various building zones or sections of the United States; (2) tightness of construction to prevent excessive leakage; (3) the amount of air space which the heat from the animal is expected to heat, and (4) the desired amount of ventilation and the methods used in securing it. Our tests show that a reasonable temperature can be maintained in a properly designed building and get ample ventilation. Two herdsmen complained that we were keeping the barn too warm when it had reached a temperature of 52 degrees. Too great stress has been put on high temperatures in the past, and it is reasonable to believe that a temperature much lower than this can be maintained without discomfort to the animals.

These tests were made under a range in temperatures of from 45 degrees above to 15 degrees below zero with an average difference of approximately 23 degrees between inside and outside temperatures. The greatest difference in temperature experienced was 55 degrees. It has been shown that even under these extreme variations a reasonable temperature may be maintained in the stable if the ventilation system is intelligently operated.

We would not expect a small stove to heat a large house, neither can we expect a barn to be warm when it is only partially filled with stock or when the volume of air to be heated by animals is unreasonably large. Some ventilation systems have been unjustly condemned for this reason.

Our study shows that under the average conditions there is a greater difference between the ceiling and floor temperatures in the horse stable than in the dairy section of the same barn. This may be explained perhaps by the fact that the breathing line of horses is higher than that of cows and that most of the body heat is given off at the higher plane. In one dairy barn a difference of 10 degrees was recorded between the ceiling and floor temperatures, but the greater part of the time the difference was less than one-half this figure. It will be evident to many that these conditions have an important bearing upon the factors related to building construction.

The area of intake openings has an important bearing upon the maintenance of stable temperature and it was possible in most of these tests to control the barn temperature by varying the amount of inlet area. The outtake area usually has a greater influence upon the amount of ventilation secured than does that of the intakes. Openings near the floor in the outtakes appeared more favorable to the maintenance of stable temperature than ceiling openings. Especially was this true during cold weather. Storm windows aid in maintaining the stable temperature. Where the leakage of air through cracks, doors, windows, etc., is excessive, it is impossible to maintain a uniform temperature in the barn, and variations in temperature inside follow closely that of the temperature variations outside.

Theoretically the value of temperature as a motive power for production of draft is known, but its practical application and correlation with the amount of ventilation which may be expected under a given set of conditions is yet to be learned. The prospects are bright for the early determination of the connecting link or constant factor, which will reconcile the theoretical and the practical.

The data from our tests show that the temperature, and the percentage of moisture in the outside air have a great influence upon the percentage of moisture in the stable air, greater, perhaps, than that due to restriction of circulation of air in the average farm barn. However, in well-insulated barns this would not be true, since the moisture given off by animals adds to the moisture in the stable air and the point of saturation is not reached unless there is sufficient circulation of air to remove the excessive moisture. In a stable housing 20 cows there is approximately 200 pounds of moisture given off per day. If this moisture is not removed fast enough, it collects on the stable walls and softens the paint or plaster which subsequently falls off; mold forms and hastens the rotting of the barn woodwork.

The most desirable percentage of humidity in the stable air has not as yet been determined as there are so many variable factors, which must be taken into consideration, and it is difficult to set a standard, but it is here suggested that at a stable temperature of 45 degrees a relative humidity of 81 per cent is satisfactory. The tests show that it is not difficult to obtain this degree of moisture when other con-

ditions are favorable. In the majority of our tests the ceiling relative humidity was less than that near the floor.

In a few of the early tests the percentage of moisture in the stable air was determined by means of hygrographs. In later tests the sling psychrometer was used with more satisfactory results. A recording hygrometer is desirable for the determination of the rapidity of variation in the relative humidity, but the sling psychrometer gives readings which are more comparable, and which at the same time are more accurate.

In referring to the amount of ventilation the term "dilution of air per hour" is preferred to the "number of changes of air per hour." The air in the stable is not completely replaced by fresh air, but part of the foul air in the room is forced out and incoming air having a lower percentage of carbon dioxide is mixed with the stable air of a higher percentage of CO_2 thus decreasing the CO_2 content by dilution. Circulation of air is dependent upon the temperatures inside and outside and the difference between these two, wind velocity and direction, and various construction features, such as the height of the flues, effective cross sectional area of intakes and outtakes, design of intakes whether intakes are of wall or window type, etc. All these conditions, and a few others of lesser importance, have a bearing upon the amount of ventilation secured. It is difficult to study separately these factors so that the part which each plays in producing circulation of air may be learned.

There is in all cases some leakage and this varies according to the tightness of the construction and the difference between inside and outside temperatures. This leakage aids in the dilution of the stable air, but large leakage is not desirable as it is impossible to control the temperature of the barn. With old stables we sometimes have what is termed "crack system of ventilation." Some ventilation is secured in this manner, but it is impossible to effectively control it. In well-built modern barns leakage is greatly reduced and effective regulation in ventilation can be secured. There is a part of the leakage which cannot be measured, but the leakage which must take place in order to balance the incoming and outgoing air can be obtained by subtraction. With but few exceptions and these under unusual conditions, the amount of measured outgoing air was greater than that of the incoming air. Leakage of air is greater at times of high wind velocities and low temperatures. In one barn when the outside temperature was 11 below zero the intakes were closed and the dampers

Summary of Average Conditions with Maximum and Minimum Reading of the Test for Each Factor of All Ventilation Tests Conducted During Winter of 1920-21

TEST		Flue Opening Square Feet		Volume of Air Cubic Feet		Per Cent of	Dilutions	Wind Velocity	Temperatures					Humidity			
No.	Readings	In	Out	In	Out	Leakage[2]	Per Hour	m.p.h.	Ceiling	Floor	Room	Out	Difference	Ceiling	Floor	Room	Barometer
A 18[1]	High	5.06	8.49	2350	3406	...	9.60	14.8	53.0	46.0	48.1	28.3	35.0	87	92	85	29.80
	Low	0.0	6.41	0	820	...	2.30	0	44.0	38.0	41.4	6.4	14.9	72	75	74	29.18
	Average %	3.66	6.56	935	1829	48.9	5.13	7.3	47.3	42.1	44.8	20.9	23.7	76	84	80	29.34
B 18	High	4.42	6.89	3524	2772	...	11.70	17.1	51.0	45.0	48.5	32.6	33.1	79	75	77	29.80
	Low	0	6.26	0	858	...	2.80	0	42.0	32.0	36.4	6.4	11.7	71	60	68	29.06
	Average %	2.8	6.29	879	1754	49.9	6.00	7.8	46.2	38.6	43.4	20.9	21.8	76	70	73	29.34
C 16	High	4.66	4.69	760	1507	...	7.80	9.7	50.0	48.0	47.0	27.2	28.5	81	86	83.5	28.55
	Low	0	3.02	0	739	...	3.80	0	38.0	40.0	37.5	10.0	16.0	69	37[3]	54.5	28.18
	Average %	3.78	3.96	280	1205	76.8	6.20	5.1	44.3	44.5	42.5	20.9	21.6	76	71	73.5	28.37
D 16	High	3.10	4.50	488	1109	...	5.90	15.8	51.0	48.0	47.0	27.2	29.8	87	85	86	28.55
	Low	0	4.50	0	623	...	3.30	0	40.0	40.0	39.2	10.0	14.8	78	69	76	28.18
	Average %	2.36	4.50	211	831	74.6	4.40	5.4	46.0	43.5	43.2	20.9	20.9	84	75	80	28.37
E 13	High	1.50	0.78	435	3915	...	11.50	40.5	47.0	42.5	44.6	23.4	28.6	85.0	85.0	84.5	28.44
	Low	0	0	0	0	...	0	1.5	38.0	34.5	34.6	6.0	14.9	71.0	65.0	76.7	28.01
	Average %	0.27	6.02	170	1717	90.1	5.07	27.5	42.2	38.8	39.6	17.4	22.1	76.3	77.2	79.4	28.19
F 13	High	2.85	13.55	1104	3989	...	7.08	26.0	50.0	49.0	48.2	23.0	28.3	93.0	86.0	88.5	29.20
	Low	1.42	5.82	280	1512	...	2.68	7.9	46.0	43.0	44.8	18.7	23.0	80.0	85.0	82.5	28.67
	Average %	2.18	12.96	704	3182	77.9	5.65	15.2	48.0	47.1	45.9	20.9	25.0	86.1	85.9	83.3	28.83
G 12	High	2.45	9.76	662	3211	...	8.60	7.9	44.2	39.2	41.7	16.0	48.6	79	85	81.6	29.12
	Low	0	0	0	146	...	0.40	0	34.8	30.6	32.7	—15.0	23.0	71	68	70.0	28.68
	Average %	0.54	6.91	125	1930	93.6	5.10	5.3	40.7	35.1	37.8	3.6	34.2	75	76	77.0	28.96
H 9	High	9.44	13.80	2401	2135	...	8.00	14.7	49.8	49.0	49.4	32.7	23.6	85	86	84	28.90
	Low	1.29	12.00	362	1004	...	3.30	2.3	41.2	38.8	40.5	17.0	16.7	75	65	80	28.24
	Average %	5.58	12.20	935	1649	43.3	5.50	7.8	46.2	43.2	44.1	24.6	19.4	80	82	81	28.57
I 13	High	2.34	9.76	926	3268	...	10.90	17.0	57.0	54.0	55.2	36.2	32.1	88	93	91	28.94
	Low	0	9.76	0	2330	...	7.80	3.1	52.0	47.0	48.6	19.6	10.8	77	82	81	28.66
	Average %	1.91	9.76	561	2794	80.0	9.30	8.4	54.9	51.0	52.3	26.3	24.4	85	88	86	28.79
J 13	High	1.31	2.24	190	997	...	10.30	17.0	49.5	44.5	46.5	36.2	23.7	81	...	...	28.91
	Low	0.90	2.24	13	403	...	4.20	3.1	44.5	35.5	40.0	19.6	10.0	61	...	...	28.65
	Average %	0.97	2.24	85	798	89.4	8.30	8.4	47.5	40.0	43.9	26.3	17.5	75	...	...	28.78
K 13	High	2.25	4.58	1012	2217	...	12.40	21.0	54.6	51.3	52.4	17.5	55.4	93	94	91	29.40
	Low	0	0	0	0	...	0	0	41.6	39.3	38.9	—7.5	25.7	78	69	76	28.78
	Average %	0.55	1.83	213	485	56.1	2.70	10.9	48.5	45.0	46.3	8.8	38.9	84	82	83	29.20
L 10	High	0	5.54	0	3395	...	4.60	20.0	56.5	53.5	55.1	42.2	23.6	88	88	87	28.38
	Low	0	5.54	0	2398	...	3.30	2.0	45.0	41.5	43.6	21.5	10.7	69	72	74	28.01
	Average %	0	5.54	0	2894	100.0	3.98	8.4	50.7	47.7	49.4	31.0	18.3	76	80	78	28.25
M 16	High	1.68	7.88	465	2598	...	9.00	14.0	45.5	45.5	45.0	29.5	40.9	92	94	93	30.05
	Low	0	7.88	0	1656	...	5.80	0	33.5	31.0	30.8	—10.2	9.6	54	64	59	29.70
	Average %	0.47	7.88	121	2223	94.6	7.80	3.2	39.3	38.2	38.2	11.2	27.0	81	84	83	29.87
N 13	High	11.52	22.90	1984	7234	...	8.10	12.5	51.6	45.0	48.3	26.6	35.3	100	100	100	29.85
	Low	7.2	20.70	1171	4580	...	5.10	0.5	40.7	36.6	38.1	4.0	18.7	86	90	88	29.49
	Average %	10.29	20.70	1662	6274	73.5	7.00	5.8	46.8	41.7	44.2	16.1	28.0	95	96	95	29.62
O 13	High	31.46	19.66	6823	2310	...	7.59	20.0	51.5	50.0	49.2	32.2	22.1	89.0	88.00	88.0	29.60
	Low	14.52	7.22	1214	1268	...	1.46	0	43.0	43.5	41.0	20.5	16.5	75.0	77.0	76.0	29.20
	Average %	22.33	10.85	3451	1769	50.5	3.85	10.9	48.2	47.4	46.6	27.4	19.2	83.8	83.5	83.7	29.43
P 10	High	14.98	29.26	2094	2853	...	3.08	12.8	57.6	54.0	55.2	34.5	26.1	95.0	94.0	94.0	29.70
	Low	7.58	13.81	944	631	...	1.18	3.8	53.4	51.4	50.4	27.5	19.0	85.0	82.0	83.0	29.31
	Average %	9.14	20.90	1619	1627	0.5	2.15	7.8	55.8	52.0	53.0	30.6	22.4	90.9	90.1	90.4	29.49
Q 8	High	3.66	7.61	413	635	...	0.116	10.1	51.0	45.0	47.5	30.8	24.6	93.0	95.0	91.0	29.31
	Low	0	7.00	0	0	...	0	0	47.6	43.1	45.8	21.7	15.0	83.0	83.0	82.0	29.15
	Average %	1.75	7.08	168	433	61.2	0.078	5.2	49.2	44.0	46.6	26.8	19.7	86.8	87.7	87.3	29.21
R 8	High	45.76	58.44	12125	108[illegible]9	...	12.92	9.5	58.4	55.0	57.3	44.7	25.6	89	93	91	30.40
	Low	9.0	29.32	1307	797	...	2.22	1.1	53.2	49.4	52.0	27.0	9.3	75	80	78	29.95
	Average %	25.9	40.00	5284	4961	6.1	6.86	4.8	55.5	51.5	53.6	35.8	17.9	83	87	85	30.20
S 13	High	12.25	15.62	1989	1966	...	7.[illegible]6	7.2	54.0	50.0	52.0	44.0	30.9	84	88	86	30.53
	Low	4.90	10.72	313	792	...	3.[illegible]5	0.5	43.6	39.6	41.6	11.0	4.4	62	65	65	30.50
	Average %	9.04	11.47	873	1356	35.6	5.39	2.5	49.3	45.0	47.1	25.3	21.7	76	77	77	30.51

[1]Number after letter shows number of readings used to obtain average. Each reading represents a test duration of approximately 3 hours.

[2]Leakage is considered the difference between volume of measured air in and out.

[3]Results doubtful as wet bulb temperature was 32°.

CAUTION—The highest or lowest reading on any one factor of a test is not comparable with the highest or lowest reading of another factor of the same test, as these readings seldom occur at the same time for any two factors. They represent the range from which the average was obtained, hence indicate the degree of variation from the average condition.

Test H was on a hog house; Test L on fan system in dairy barn; Barns E and F contained mixed stock; Tests B, D, and G were in horse barns; all other tests were made in dairy barns.

in the outtakes were closed, yet there was a measured leakage around the dampers sufficient to produce 1.4 per cent dilution of air in the stable per hour.

In these tests there was a range of from zero to 13 dilutions of air per hour and in many cases the full capacity of the system was not used. In one test the system was wide open, yet there was less than 0.1 dilution per hour, or in other words, it would take 10 hours to make one dilution of the stable air. This condition will be discussed in our final report.

A few of the barns tested used hot-air furnace registers on the intakes and in some cases for the heat door in the outtakes. Such registers are entirely unsuited for this purpose. The slats rust, become broken and collect dirt and cobwebs. During cold weather they collect frost and sometimes the entire area is ineffective. The grates and shutters retard the free passage of air. If no better means is available, a board, either hinged or sliding in a slot is superior to the furnace register. It is necessary to screen the outer opening in the inlet ducts to prevent entrance of thrash and vermin, but the passage of air through the inner opening should be unobstructed except as it becomes necessary to restrict the amount of ventilation by partial closing of the opening.

In some of the tests an interesting condition arose. When the intakes had been closed for sometime, the velocity of the air through the outtakes was greatly increased after the intakes had been opened. This may be termed a "ballistic" action, probably due to the immediately decreased resistance to the suction of the ventilators. The following reading showed decreased velocity and it is assumed that the ventilation had adjusted itself to the new condition.

The agricultural engineer knows within reasonable limits the amount of air necessary to produce a desirable purity of air in a stable. He has been told the amount thought suitable for a cow, horse, pig, etc., and these factors hold true regardless of the motive power. With mechanical motive power, it is easy for him to estimate the size of fan and the amount of power necessary to do the work.

The forces which produce the desirable amount of circulation of air in the natural draft system are wind, difference in temperature between the inside and the outside air and their related factors. The wind varies considerably and likewise the temperature. The velocity of the wind is given very little consideration as an aid in producing the desired circulation of air, but the temperatures must be given careful consideration. It is known that the construction details have important bearing upon the stable temperature, but we have given too little attention to the motive power which is largely responsible for producing a circulation of air in the barn.

However desirable and important it is to have plenty of fresh air in the stable, it is also important to maintain a stable temperature which will be comfortable to the animals. It has been demonstrated that an ample circulation of air and a comfortable temperature in the barn may be maintained if the building is properly designed. It would be just as sensible to try to heat a large room with a kerosene lamp as to expect an animal to heat a space which is much too large for it. When building a barn careful consideration should be given to the space provided for the animals since they are the source of the heat. Certain volumes of air space have been suggested for the different animals and we may use these as a basis for our designs, but we have yet much to learn in this respect. A careful study of the number of square feet of radiating surface and the capacity of a furnace is essential to the success of well-designed heating systems. Hence the heat produced by the animal must be given careful consideration as it is expected not only to warm the stable, but to furnish the motive power to produce circulation of air as well.

Dr. H. P. Armsby[1] has given us an excellent working basis with respect to the heat generated by a dairy cow, and we may accept his suggestions for hogs and sheep, but there is some doubt as to the advisability of using that unit which has been proposed for horses. This unit will be given further consideration.

The question of animal heat is very interesting but at the same time one of the most complex questions of physiology. The calorific energy produced by an animal usually is more than enough to maintain the temperature of the body and the surplus is given off or radiated into the air. Animals possess the faculty of regulating the production or loss of heat, an ability which is particularly prominent in warm-blooded animals and which they exercise under most diverse conditions. However, there is a limit to such regulation. Resting, working, lactation, environment, fattening, and the two factors which always enter into the calculations, weight and size, all have their influence upon the production of heat. Hence, it is obviously impossible to set a definite unit of heat production for the individual animal, but we may use as a working basis the average heat production of the animal under average conditions. It is not necessary to study the intricacies of animal nutrition, but it is desirable that the agricultural engineer know those factors which have an important bearing upon the proper ventilation of stables.

Dr. Armsby has shown that there is an important relation between the amount of ventilation needed and the heat given off by the animals. He has also pointed out that calorification varies inversely with the weight of the animal, but not in exact proportion. Rameaux in 1857 formulated the following law: "**In animals of the same kind the calorification is proportional to the cutaneous surface and to the cube root of the square of the weight of the body.**"

The animal heat radiating from the skin is by far greater in amount than that given off through other channels. When the skin surface of animals of the same kind is compared with their weight, it is found to be greater, in proportion, in the smaller animal. If the quantity of heat produced by an animal in 24 hours is compared with the area of skin surface, the relation between them is remarkable.

The relative heat production of the hog, man, dog and mouse per square meter of skin surface per 24 hours has been given as: 1.078; 1.042; 1.030 and 1.188, respectively. This relation has been confirmed by the experiments of Rubner, Camerer and Stovtzoff. The relation between the first three is indeed remarkable and it would seem that it is not unreasonable to assume that a similar relation exists between the heat production of the horse and the cow which are more comparable with respect to weight, food and environment than are the animals mentioned above.

Dr. Moulton of the University of Missouri has determined that the surface area of steers of medium or thin condition is proportional to the 5/8ths power of their live weight, and that for fat steers it is proportional to the 5/9ths power. Voit held that the heat given off as computed per square meter of surface is substantially the same in small and large animals and that the extent of surface appears as the determining factor in the amount of metabolism. Then may we not assume that within the limits of their respective weights and surface areas the heat given off by horses is more nearly that given off by cows than is suggested by Dr. Armsby in his article "Some Fundamentals of Stable Ventilation," especially since Voit, and likewise Dr. Armsby, believed that the data upon which the Armsby unit was based is of uncertain value and that his unit is too low.

Data secured in tests of two widely-separated barns of different construction made under different atmospheric

[1]"Some Fundamentals of Stable Ventilation," Journal of Agricultural Research, June, 1921; also July and August, 1921, issues of AGRICULTURAL ENGINEERING.

conditions give further evidence that this unit is too low. Our deduction is made on a basis entirely different from that used by Voit and Armsby, and this adds further weight to the contention. It is not possible, at this time, to place a definite value on the heat production of horses, but from all these data there may be deduced certain general conclusions which may be accepted, at least tentatively, and which may be considered as connecting links between the known facts. We must conclude that until further research shall give us a more definite unit to use it would be advisable to base our designs for ventilation systems in horse barns upon the unit suggested by Professor King.

It is not possible to give the mass of tables involved in tests of this kind without making the discussion too long. These data as given in the accompanying table represent the minimum and average conditions found during each test. The reader who is unfamiliar with other conditions in these barns which affect the average results, is cautioned against the use of these data for interpretation and comparison with other tests unless a true comparison is evident. Measured leakage in Test "P" was the smallest of any test, and was indicated as 0.5 per cent. However, in this case the unmeasured leakage through cracks, doors, and around windows, etc., was undoubtedly large. These data are given more to show the scope of the work and to indicate the information which will be available when the work is completed. It is obviously impossible to give much detail in a report of this kind.

Need of a Country Plumbing Code*

By H. H. Musselman
Mem. A.S.A.E. Professor in charge of Farm Mechanics, Michigan Agricultural College

COUNTRY plumbing is closely related to the problem of water supply and sewage disposal and, as a part of that problem which has been given so much attention by the American Society of Agricultural Engineers, may properly come in for its share of attention.

The more closely people are crowded together the more apparent is the need for regulation of the systems of water and sewage disposal. A noted sanitary engineer said not long ago that "the modern city may be judged by its sewage system."

Because the need has been apparent and immediate, cities and some few states have worked out regulations and codes for the control of material devices and construction to be used in carrying such wastes and sewage. These codes have had the effect of standardization of equipment and work in plumbing in the cities.

Some states have deemed the problem of sufficient importance to enact regulations applicable to the whole state; the tendency seems to be to give more careful attention to safeguarding the individual against the dangers incidental to ignorance and neglect of good practice in this branch of sanitation.

In agricultural-college work dealing with education along the lines of water supply and sewage disposal new angles to the problem are presented. Undoubtedly the highest class of plumbing practiced in the cities is sufficient for the country. On the other hand, it may be asked whether all the refinements specified in the city ordinances are necessary for the country. For illustration, it is easy to see that an elaborate system of back venting may be of importance in a many-story building with its multiple city fixtures which are used by people who have no knowledge or interest in their successful operation. Perhaps in connecting a sewer from a dwelling to the street and where a volume of gas may form a pressure, it would be necessary to place a trap in the outlet sewer from the house. The heaviest quality of pipe may be specified to remove all danger from breakage when used under such a variety of conditions.

It would seem that some modifications ought to be made in the interest of economy and simplicity for country conditions. On the other hand, it might be maintained that standards of any kind are not necessary or applicable in the country. To show the need it is only necessary to point to the wide variation of both material and workmanship which is used at the present time. It must be recalled that in many sections of the country plumbing is done by the local plumber who is none too skilled in the practice of his trade, the handy man in the local hardware concern, and sometimes by the farmer himself. Under these conditions a great deal of ingenuity and originality may be exhibited, but the party for whom the work is being done has little protection against bungling work even though he may be anxious to secure a first-class job.

Instances have been known where vent stocks were connected to chimneys to save pipe or cutting through the wall and ending near a window, or traps made of lead pipe with perhaps not ½ inch depth of seal and soil stock calked with putty. Both parties to the contract need specifications with the stamp of approval of the American Society of Agricultural Engineers for the work which will suit the needs of the case, which will insure safety and satisfactory operation, but which will not impose unnecessary financial burdens on the man whom the college extension specialist persuaded to take this important step forward.

At any rate it is believed that a country plumbing code sanctioned by the American Society of Agricultural Engineers would serve more as guide for country work than as an enforceable standard. It is believed that the situation calls for expansive inspection and enforcement.

The man on the farm has a more immediate and necessary interest in equipment of this kind than the man in the city, and it is to be hoped that a program of education may be so effective that it may never be found necessary to enforce good practice by law.

In a canvass of the need for a country plumbing code to members of the American Society of Agricultural Engineers interested in conveniences, a large majority felt that the present practice does not conform to good standard practice and a larger majority felt that a code adopted by the American Society of Agricultural Engineers would be of value in raising the standard. Few of the states have plumbing codes. In Ohio the state code seems to have benefited the country by bettering the grade of work done by plumbers in the cities and towns, who also do a good deal of work in the country. Many think that specifications need not be as rigid for workmanship in the country, as is also thought of joint connection traps, cleanouts and piping regulations, while others say that they should be the same. Screw joint would generally be permitted.

Opinion is also divided on the necessity of back venting, but opinion is quite general that inspection is not necessary or possible. The septic tank is favored as a final means of disposal.

There are many points open to discussion and it is recommended that the committee on sanitation work out a tentative code for consideration by the Society.

*Paper presented at the fifteenth annual meeting of the American Society of Agricultural Engineers, Chicago, December, 1921.

Agricultural Engineering in Land Settlement

By Max. E. Cook

Mem. A.S.A.E. Farmstead Engineer, California Land Settlement Work

AGRICULTURAL engineering constitutes the largest and most important part of the California land settlement work. In connection with the land settlement project at Delhi, for example, the work of the farmstead engineering department bears out this fact in a great variety of ways. The activities of this department embrace not only planning, designing, quantity surveying, obtaining competitive bids, letting contracts, and supervising the construction of all classes of farm, town, and administrative buildings, but include also making individual farmstead layouts for all settlers, determining location and arrangement of buildings, lanes, corrals, poultry runs, domestic wells, orchards, vegetable gardens, etc. Individual settlers are given unlimited consultation in acquainting them with health recommendations relative to sewage disposal, protection of domestic water supply, insurance rates and hazards, requirements of good practice in plumbing, electric wiring, paint formulas, concrete mixing, chimney construction, carpentry, etc. All buildings are appraised and values set as basis for loans, and all buildings rented are scheduled by this department.

Active interest and support are given to community development, services being extended to school boards and settlers cooperative associations. This includes designing and supervising the construction of the community hall which was recently completed at Delhi.

The farmstead engineering department is maintained in recognition of the value of planned development. Through this department the settlers time has been conserved and better buildings have been built at less cost than would have been possible had each farmer been obliged to make repeated trips to town for materials and assistance.

It has been demonstrated beyond question that when buildings are properly designed, planned, and built to meet individual requirements, contentment and success are more liable to follow than in cases where no organized effort is at work.

Loans made by the state are more securely protected and appraisals of building improvements are more accurately made with costs and building data amassed by this department as a basis.

In cases where a settler is more or less of a mechanic, and is in a good position to do his own building, he is advised to do so. In all other cases the contract system has proven most satisfactory. In either case a complete set of plans is furnished.

Under the contract system a set of specifications is drawn, and after the plans and specifications have been approved by the settler the work is advertised for bids in the open market in accordance with regulation practice. Sealed bids are received and opened at a predetermined hour in the settler's presence. If accepted, and on receipt of authorization with accompanying deposit by the settler, a contract is entered into between the state and contractor, and work proceeds under the supervision of the farmstead engineer acting as agent of settler until completion and acceptance. The contractor's accounts are audited and the full responsibility is removed from the settler until he accepts the work as complete and satisfactory to him. This service is a complete architectural professional service. The contractor is responsible for accident to his workmen or the public, for loss by fire, and is under bond for faithful performance of the contract.

Where a settler is able to do his own building work, a quantity survey of the materials required is made, and competitive bids taken on these materials in the same way that bids are taken on labor and material contracts. The settler is furnished a copy of the material list to serve as a guide, the list giving instructions for the cutting and placing of various items thereon.

Wherever it has been possible to purchase building materials in carload or large quantities by grouping orders this has been done to give the settler the benefit of the state's purchasing power.

By a careful system of checking contractors accounts, and by requiring detailed statements from settlers before loans are made, labor and material men are given positive protection, saving them collection costs and making their business through the state very desirable. This is an important factor in keeping down costs.

Our well established contract system with its uniform and well known methods of procedure has earned the confidence of local contractors and has created a wide and keen competition.

The first building contract was awarded March 4, 1920. Today there are four hundred and fifty-four buildings on the settlement, they having been erected at the rate of a building every 1.5 working days. Three hundred and thirty-nine are farm buildings on one hundred and thirty-two farms at a cost of $177,749.00 including domestic wells, or $1346.00 average per farm. There are eighty-six buildings on fifty-one farm laborers blocks at a cost of $51,788.00, including domestic wells, or an average of $1116.00 per farm laborers block. There are twenty-six administration buildings representing a cost of approximately $85,000.00. The Wilson Community Hall cost $10,000.00. The total value of all the buildings on the settlement, including domestic wells, amounts to $325,000.00. Over $170,000.00 of this amount was spent under contract; $81,000.00 was produced by settlers labor from plans furnished by us; $72,000.00 has been spent following settlers plans, but with construction supervised by this department. Ten per cent is a conservative estimate of the cost saved by this department in letting the work under contract. Still greater saving is effected through the intelligent planning of buildings and by the utilization of the most suitable materials and of standard sizes that avoid waste.

Where special plans have to be prepared a charge of three per cent of the value of the work is made by the land settlement division. Where stock plans are usable the charge is two per cent, which has made this department self-supporting considering its contribution to general administration. It has also produced administration buildings at a cost of three per cent of their cost.

As in the case of all other buildings, the determination of the amount to be expended and the type of each dwelling to be erected is based on a personal interview with the individual settler and a thorough knowledge of his requirements. There are three distinct ways of commencing the dwelling program, requiring earnest consideration. A dwelling may be designed with only the ultimate needs in mind, and more or less without regard to cost, being so planned that it may be built in units within reach of available cash.

The shell or skeleton of the dwelling may be built with a view to completing it in installments during the winter months and at odd times or as capital permits, or a temporary dwelling of a type suitable for converting to some utility use may prove most satisfactory. The latter type is the cheapest for all of the material within it peculiar to a dwelling may be salvaged for later use in a permanent structure, leaving a higher type of utility building than perhaps could have been afforded otherwise. The complete unit costs the most for a corresponding amount of space for the reason that it is built with permanency in view.

Personal characteristics of the occupants play an important part in determining which path to follow. The temporary dwelling must not become permanent, the shell is not satisfactory unless completed and new units should follow with increases in the family and expansion.

The type of poultry house adopted at Delhi as a standard is the University of California recommendation with a shingle roof and other minor exceptions. There is on the settlement today poultry housing capacity for 30,000 laying hens. If built end to end the housing would be a mile long. Over 23,000 of the total capacity is in the standard house at a cost of $22,120.00 or 95 cents per hen. Remaining poultry houses are of various designs at a cost of $7862.00 or $1.18 per hen.

The California type of barn with central hay storage and wings at either side is the most economical type and lends itself very well to erection on the unit system. Barns are located with relation to other buildings so that grade A dairies are possible. The smaller barns are designed so that it is possible at a later date to convert into general-purpose buildings such as are more suitable to an orchard or vineyard development. Plans are under way for the erection of the first silo which will be of the farm bureau wood-hoop type.

There are eighty-four 1½ and 2-inch hydraulic wells and sixty-two 7-inch cased wells on the settlement. The 7-inch cased well is recommended for domestic supply and the average depth of such wells on the settlement is sixty-six feet, with fifty-five feet of casing at an average cost of $108.00. The water stands in the wells at depths varying in the settlement from fourteen to twenty-five feet, with a limited few of a greater depth, and an average of approximately eighteen feet.

Loans to settlers on buildings are based on itemized statements of cost and bills and receipts produced by the settler, checked against current costs and backed by personal inspection and appraisal.

There has been $95,000.00 loaned on buildings and wells, over $70,000.00 of which has been certified on one hundred and seventy-one separate certifications of inspection and analysis, the remainder on forty-nine separate improvement and construction contracts.

Standards of Terracing*

By **J. T. Copeland**

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THE agricultural terrace is designed for the economical prevention of erosion and for reclaiming lands which have become unprofitable through exposure to the natural and free course of water.

Coefficient of vertical distance for terracing a given slope is ascertained by measuring the vertical distance between the top of the slope and the upper extreme of the topmost natural wash or erosion of the slope. The measure thus obtained becomes the factor or coefficient of vertical distance between terraces, and should be maintained in its use until the grade of the slope warrants the use of the multiple of the coefficient.

SPREAD, OR LATERAL DISTANCE, between terraces should not exceed 300 feet. Usually the slope and the coefficient of vertical distance act as the limiting factors of the spread.

FALL, OR GRADE, is considered in inches fall per hundred feet as:

(1) 1 to 2 inches giving soil deposit;
(2) 2 to 4 inches little or no soil deposit; and
(3) 4 to 8 inches scouring terrace.

LENGTH of terrace should not exceed 2000 feet.

CONSTRUCTION OF BROAD TERRACE. The most economical and universal equipment for terrace building, under ordinary circumstances, consists of 10-inch or 12-inch turning plows, slip scrapers, and V-drags. (The directions and suggestions here set forth shall be as a guide or standard by which terraces made by other means may be gauged.)

With the line of terrace indicated by stakes set regularly at 50-foot distances and of the desired fall, the line is "walked out." To walk out a terrace the "walker" starts at one extreme of the terrace and in walking averages the irregularity, or deviation from a smooth curving course of the two immediate stakes forward. The walker's course is followed with a furrow which becomes the ridge furrow of a land or course twelve or fourteen furrows wide. With the landside of the V-drag following the last upper furrow it is necessary to drag a sufficient number of times to raise a 4 to 6 inch ridge 4½ feet from the path of the landside. The course is replowed, the ridge-furrow of this plowing falling upon the ridge made by the drag. The first plowing gives the terrace width, while the second increases the depth of trough and height of bank. The second process of dragging should complete a terrace 18 to 24 inches deep, varying in width from 18 to 24 feet. Any depressions in the terrace bank should be graded up with slip scrapers, raising the bank fully one-fourth higher at the point of fill, to allow for settling.

By following the foregoing as fundamental rules or standards of terracing, heeding the natural coefficient of vertical distances, by dividing the grade at the shoulder or point of the slope to avoid excessive lengths, and by diverting the water in the reverse direction of the natural outlet, much embarrassment and loss of time through mistakes may be avoided.

*Part of the report of the Committee on Drainage presented at the fifteenth annual meeting of the American Society of Agricultural Engineers, Chicago, December, 1921.

Marsh Plow Development

F. W. DUFFEE of the department of agricultural engineering, University of Wisconsin, has been doing some valuable research work in the development of an improved marsh plow. By using a larger coulter, a heavier frame, a stronger wheel, and a landslide longer and higher, a plow has been devised which works exceedingly well on marshes. It will go through almost any amount of trash and sod without clogging. It turns the furrow directly upside down and practically completely covers the trash, leaving the furrow slices lying flat in condition for working the seedbed.

Agricultural Engineering Development

A Review of the Activities and Recent Progress in the Field of Agricultural Engineering Investigation, Experimentation and Research

Edited by **R. W. Trullinger**
Mem. A.S.A.E. Specialist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

FIELD EXPERIMENTS ON A PRACTICAL IRRIGATION RATING BOX, G. C. Jacob and H. R. Leach. [Engineering News-Record, New York. 88(1922) No. 13, pp. 530, 531, figs. 2.] Studies conducted at the Uintah Basin irrigation project on the modification of rating flumes on certain of the main canals to prevent nonuniformity in ratings due to silting above or below the flumes are reported. This was accomplished by throttling the flow through the flume at the lower end by means of wings projecting into the flume at right angles to the sides, the opening between the wings being in general one-half of the original width of the flume. The experiments led to the permanent adoption of a simple, rectangular flume of a length four times its width, contracted as stated, and designed to have a free overfall at the discharge end similar to an irrigation drop.

Experiments with four different boxes with widths of 2, 3, 4, and 5 feet led to the determination of the formula for flow, $Q = 3.69\ LH^{1.52}$, in which Q is the discharge in second feet, L is the width of the notch in feet, and H is the head on the notch measured a distance equal to the width of the box above the notch. This formula was found to give the discharge of the box up to a head equal to the width of the notch. In only five out of one hundred and thirty-four observations made under standard conditions did the discharges computed by the formula differ from the observed discharges by more than 0.1 second-foot.

Metal and wood contractions gave the same rating. No difference in the rating of boxes of a length either three or four times the width could be detected in the cases of the two and three-foot boxes. In the case of the four-foot box the discharge was somewhat lower for the short box. A slight change in the ratio of notch width to box width did not affect the rating materially. Submergence decreased the discharge, but it required a submergence of twenty-five per cent of the head to decrease the apparent discharge of five per cent. It required material obstruction at the entrance to change the rating appreciably.

LAND DRAINAGE, W. L. Powers and T. A. H. Teeter. [New York: John Wiley & Sons, Inc., 1922, pp. IX + 270, figs. 106.] This book is one of the Wiley agricultural engineering series, edited by J. B. Davidson, and deals with the subject of drainage primarily from the agricultural viewpoint. The subject is developed largely as a matter of applied soil physics. It contains chapters on development, importance, and future of drainage; benefits of drainage; the relation of soils to drainage; forms of soil water; types of drains and their location; materials for covered drains; depths and frequency of tiles; measurement of drainage water; size and grade for tiles; construction of underdrains; cost and profit of tile drainage; development of wet lands; drainage districts and drainage laws; assessment of drainage benefits and costs; large tiles *v.* open ditches; design, construction, and maintenance of open ditches; estimate of costs of drainage systems; the drainage of tidal and overflowed marsh lands; the drainage of irrigated lands; miscellaneous drainage problems; and drainage surveying and practice.

REPORT OF AN ENGINEERING INVESTIGATION ON THE MAINTENANCE OF DRAINS ON RECLAMATION SERVICE PROJECTS, C. E. Lounsberry, [Reclamation Record (U.S.) Washington, 13(1922), No. 1, pp. 1-4.] Data on unit costs of maintenance of open drains for the period from 1917 to 1921, inclusive, on nine U. S. reclamation service projects, having an average total length of drains of 351.13 miles, are tabulated. The average unit costs per mile year were, for patrolling, $6.10; clearing of weeds and debris, $17.96; clearing of silt and caved material, $16.32; repairs to structures, $11.63; minor expenses, $3.90; and overhead, $14.76.

Data for a similar period on unit costs of maintenance of closed drains on six projects, having an average total length of drains of 158.53 miles, showed that the average unit costs per mile year were, for patrolling, 53 cents; clearing tile and trap boxes, $14.72; repairs to tile and trap boxes, $31; minor expense and plant and equipment charges, $2.54; replacement of drains, $2.15; and hydrometry, one cent per mile year.

THE USE OF CALCIUM CHLORID IN CONCRETE HIGHWAY CONSTRUCTION, B. H. Piepmeier and H. F. Clemmer [Engineering and Contracting, Chicago, 57(1922), No. 14, pp. 323, 324, figs. 2.] Laboratory and field investigations by the Illinois division of highways on the use of calcium chlorid in concrete road construction are reported. It was found that calcium chlorid accelerates the setting of concrete in cold weather and may be used as a simple and practical means of curing.

In laboratory studies of over four hundred and fifty specimens it was shown that the greatest transverse strength was developed in those specimens treated with calcium chlorid, and the best results were given by specimens, the bare surfaces of which were sprinkled with the granulated chemical at the rate of three pounds per square yard of surface. This method of curing resulted in stronger specimens at the end of fourteen days than did the wetted earth method at the end of twenty-eight days. The beneficial effect of calcium chlorid in such use occurs chiefly within the first twenty-four hours after its application.

Investigations bearing upon the effect of placing concrete at low temperatures indicated that under such conditions calcium chlorid incorporated in the mixture at the rate of from two to three per cent of the weight of the cement produced the best results in hastening the setting process, in securing an earlier strength, and in preventing injury to the road by the action of frost or freezing.

A PROPOSED UNIFORM LAW FOR LAND RECLAMATION BY DRAINAGE, J. A. Harman. [Engineering News-Record, 88(1922), No. 17, pp. 692-699.] This article outlines the current situation as regards drainage laws, states the requirements of an ideal law, and gives an explanation and complete digest of a suggested general drainage law for state enactment.

A. S. A. E. and Related Activities

Personals

JOHN BARTON BARTHOLOMEW, elected an honorary member of the American Society of Agricultural Engineers in December, 1921, entered the employ of the Avery Company as a boy more than forty years ago. He started out by doing odd jobs about the factory, and was promoted successively to service man, salesman, branch house manager, sales manager, vice-president, and finally to president. He has held the position of president of the company for a number of years.

JOHN BARTON BARTHOLOMEW

Mr. Bartholomew, both as an inventor and as a manufacturer, has rendered valuable service to agriculture, particularly along the lines of agricultural engineering; he has contributed some outstanding improvements to farm machinery. He was one of the original inventors of the pneumatic windstacker and the inventor of the Bartholomew self-feeder. He was an inventor of the old steam-lift plow, and the more recent self-lift plow was originally worked out by him. He was the first to use renewable inner cylinder walls and adjustable main bearings for tractors.

He has for a long time been prominent in the activities of the National Association of Farm Equipment Manufacturers, especially in the tractor and thresher department of that organization. He is at present chairman of the executive committee of the Association, and will be the new president of it after October of this year.

L. J. FLETCHER, professor in charge of agricultural engineering at the University of California, has just completed a report of very successful extension tractor schools conducted in that state. Extension work for his department for the coming year includes, in addition to the tractor work, farm lighting and farm water supply schools, together with a limited amount of concrete work, mainly septic tank construction demonstrations.

J. F. FORREST is the owner of what is known as the "Electric Farm," which has had considerable publicity because of the fact that he is using windmills for power to generate electric current for charging storage batteries. He has been using a 12-foot power windmill for over twelve years for lighting his house and barns, and the batteries are still in excellent condition and good for several years to come. For power purposes he uses a 16-foot wheel on a 50-foot tower. The generator develops up to fifteen amperes on an 80-volt battery. This storage battery is used in an electric automobile which is used for short trips and to furnish power to run the dozen or more individual motors which he is using on the farm. Mr. Forrest has been visited by several prominent windmill manufacturers who are interested in building electric windmills.

JOHN R. HASWELL, specialist in farm mechanics extension, at the Pennsylvania State College, is doing special work in connection with the installation of farm septic tanks. In this work they are building the Cornell single-chamber tank, and the slogan "Save the forms" has resulted in eight counties having wooden forms on hand as against eleven counties which have built tanks and for various reasons the forms have been wrecked. Three of the eight counties have at least two forms in use. Excellent progress is being made in this work in extending the use of septic tanks on farms.

MARK HAVENHILL, extension agricultural engineer at the Kansas State Agricultural College, has started investigational work on soft water cisterns and filters to be used in connection with them. The object of this work is to obtain definite data as to sizes of cisterns to build for certain amounts of rainfall, and certain sizes of roofs, etc., to establish definite construction specifications or standards.

L. G. HEIMPEL, in charge of agricultural engineering at the MacDonald College, is pioneering the agricultural-engineering idea in the Province of Quebec. Tile drainage is just being started. Water used on farms of the province is taken from the well by means of a windlass or by the still more crude method of the weighted lever or pole see-saw raising device. Modern water supply and sewage disposal systems have scarcely been thought of. The problem confronting the agricultural engineer is not so much one of research as trying to get farmers to use better methods already known. The agricultural engineering course of MacDonald College is patterned after the most modern courses given in American colleges. Ten courses of lectures and laboratory work are included in the course leading to the B. S. A. degree.

C. C. HERMANN, who until May 1st of this year held the position of chief engineer of the Litchfield Manufacturing Company in charge of all engineering, on that date was also placed in charge of manufacturing production for that company. He was formerly connected with the engineering department of Deere & Company.

A. H. HOFFMAN, who is engaged exclusively in experimental work in the agricultural-engineering division of the University of California, at Davis, is just completing a series of tests on twenty-six air cleaners for tractor motors to determine dust separating efficiency, vacuum, and effect on the maximum power of the motor. Efficiencies have been found ranging from about 40 per cent to 99 per cent, vacua from two to thirty inches of water for certain conditions of power of the motor and amount of dust in the tested cleaner. The effect on power is found to be slight; however, the wet, dry, and oil types show interesting differences.

FREDERICK W. IVES, professor in charge of agricultural engineering at Ohio State University, has just completed a group of farm buildings for that institution, which represents an expenditure of half a million dollars, giving Ohio a set of buildings that is very complete, and which contains some interesting experimental features.

Clark E. Jacoby, president of Clark E. Jacoby Engineering Company—who is also president of the National Drainage Congress of America—specializes in drainage, levee, and reclamation projects. His company has just completed the supervision of construction of a levee and drainage district near Kansas City costing $300,000; they have under way another work which will cost $1,225,000.00, and are at present preparing plans and organizing a project to cost $1,000,000. They are making preparations to devote a great deal of effort in the near future to the development of soil drainage in the territory surrounding Kansas City, Missouri.

M. E. Jahr, for more than three months beginning May 1, was connected with the land clearing work in northern Wisconsin as technical assistant in the agricultural engineering department of the University of Wisconsin.

E. R. Jones, professor in charge of agricultural engineering at the University of Wisconsin, reports that the big thing his department is accomplishing is a closer relationship with the College of Engineering. Long course students in agriculture are given a general training in agricultural engineering, but to make agricultural engineers of them they are required to take more elective work in mathematics and mechanics in the College of Engineering than the curriculum of the department of agricultural engineering permits. This work requires five years but the student receives a master's degree in agricultural engineering at the end of that time. Students in mechanical and civil engineering, who, upon entering their junior year, have a leaning toward agriculture may take elective studies in soils and agronomy and in farm machinery, farm buildings, and drainage.

S. P. Lyle, formerly connected with the agricultural engineering department of the Iowa State College is now head of the agricultural engineering department of the State Agricultural School, Jonesboro, Arkansas.

J. T. McAlister has left the department of agricultural engineering at the Mississippi A. & M. College to take charge of all agricultural-engineering work this year at Clemson College, South Carolina.

Robert R. Thomson has resigned as assistant professor of agricultural engineering at Ohio State University to take a similar position with the University of California at University Farm, Davis.

Ventilating Code Submitted for Approval By A.E.S.C.

The code for the ventilation of public and semi-public buildings adopted by the American Society of Heating and Ventilating Engineers in 1915 has been submitted to the American Engineering Standards Committee for approval as "American Standard."

This code was prepared by a committee of the American Society of Heating and Ventilating Engineers in response to requests from state commissions, legislative bodies, public health agencies and other organizations for suggestions to be used in the preparation of legislation and regulations regarding the heating and ventilation of buildings. The committee endeavored in this code to cover the general features most essential to the public health, in such a manner as to protect the public with the least possible expenditure for equipment and without unnecessarily limiting the methods of obtaining the desired results.

Section 1 of the code relates to general matters pertaining to all classes of buildings; the remaining three sections relate to schools and colleges, factories, and theatres, respectively.

Among the states that have utilized parts of the code in their regulations are: Illinois, Indiana, Kansas, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Utah, Virginia and Wisconsin. A thoroughly representative special committee, including all the important organizations interested in the subject, has been appointed by the American Engineering Standards Committee to investigate the status of the code in the industry and the desirability of approving it. Sidney J. Williams, chief engineer of the National Safety Council, is chairman of this special committee.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of this code, and to receive any other information regarding the code in meeting the needs of the industry.

Approval of Existing Standards By the A.E.S.C.

The American Engineering Standards Committee has decided to withdraw the special clause in its Rules of Procedure which provides for the approval of existing standards without going through the machinery of a sectional committee. The provision in question reads: "Any standard adopted or in process prior to January 1, 1920, may be approved by the Main Committee, if, in its opinion, the standard has been developed by an organization and procedure substantially in conformity with these Rules, or it has, by actual practice, proven its right to become a standard."

The elimination of this provision will become effective January 1, 1924. The purpose of the provision was to make easier the transition to the broadly representative plan for the preparation of national standards through the systematic cooperation of all interested bodies. In deciding upon this withdrawal, it was the feeling of the American Engineering Standards Committee that the systematic method of cooperation through the regular machinery of sectional committees, in which so large a number of bodies are now participating, has been so thoroughly tried out and has proved so satisfactory in practice that better results will be obtained by using the regular method in all cases. Furthermore, by setting the date for formal withdrawal a year and a half ahead, ample time will be given all interested organizations to submit such of their existing standards, or of those in an advanced state of preparation, as are thought suitable for approval by the American Engineering Standards Committee.

The method which has been developed for dealing with a standard submitted under this special provision is as follows: A notice of its submission is sent to the technical press, and to the industrial associations and technical bodies interested, requesting information as to the adequacy of the standard in meeting the needs of industry. The matter is referred to a special committee for investigation. In order to carry out the spirit of the sectional committee method, such special committees contain representatives (accredited for the purpose or as regular members of the A. E. S. C.) of those bodies most concerned with the standard under consideration, including the organization submitting it. Usually only organizations most directly concerned are represented. This permits such special committees to be smaller, and hence better fitted for prompt action, than they would be if made as large and broadly representative as is the case of regular sectional committees.

Generally, each member of the special committee is able, either formally or informally, to reflect the attitude of the organization he represents. This is supplemented by the information secured from the correspondence resulting from the formal publicity statements referred to above, and by any other steps which the committee may find it advantageous to

take. As in all its work, the A. E. S. C. does not consider technical details, but only procedure and status.

In connection with the consideration of an existing standard for approval, attention is also given to the formal designation of one or more organizations to serve as sponsors (usually, but not necessarily, the body or bodies submitting the standard) to provide for future revisions.

Twenty-one standards which were already in existence have so far been approved by the A. E. S. C., six as "American Standard," fourteen as "Tentative American Standard," and one as "Recommended American Practice." Twenty-eight additional standards have been submitted for approval.

It is the hope of the Committee that cooperating bodies will give early consideration to determining which of their existing standards it is desirable to submit to the A. E. S. C. for approval under the special provision in question while the provision remains in effect.

New Members of the Society

MEMBERS

DARISI CHENCHIAH, professor of agricultural engineering, National University, Adyar, Madras, India.

EARL HORACE DANIEL, general manager and chief engineer, London Motor Plow Company, Springfield, Ohio.

TRANSFER OF GRADE

EDWARD FABIAN BYERLEY, mechanic, Kimball Motor Company, Lincoln, Nebraska. (From Student to Junior Member.)

ISRAEL PARK BLAUSER, Basil, Ohio. (From Student to Associate Member.)

WILLIS W. BRITTAIN, Horse Shoe, N. C. (From Student to Junior Member.)

BURR SIMMONS EICHELMAN, binder expert, Emerson-Brantingham Co., Rockford, Ill. (From Student to Junior Member.)

GUY GARRET GLUNT, Union City, Indiana. (From Student to Junior Member.)

B. PARKER HESS, salesman, Oliver Chilled Plow Works, Columbus, Ohio. (From Student to Associate Member.)

FRANK ASSHER NAUGHTON, Jr., harvesting machinery expert, Emerson-Brantingham Company. (From Student to Junior Member.)

JOHN CALDWELL RALSTON, Jr., Caledonia, Ill. (From Student to Junior Member.)

JAMES AUGUSTUS WALLER, JR., instructor in agricultural engineering, Virginia Polytechnic Institute. (Farm Student to Associate Member.)

W. LELAND ZINK, instructor in agricultural engineering, University of California. (From Student to Associate Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to election.

Horace L. Smith, Jr., secretary, Doylestown Agricultural Company, Inc., Doylestown, Pa.

FOR TRANSFER OF MEMBERSHIP GRADE

Raymond C. Kelleher, Lansing, Iowa.

Book Review

FARM BUILDINGS, by W. A. Foster, farm building specialist, agricultural engineering section, Iowa Agricultural Experiment Station, Ames, Iowa, Member A. S. A. E., and Deane G. Carter, formerly associate professor in charge agricultural engineering department, North Carolina State College of Agricultural Engineering, Member A. S. A. E. This volume is one of the Wiley agricultural engineering series, edited by J. Brownlee Davidson, professor of agricultural engineering, Iowa State College, and a prominent member of the A. S. A. E. It is published by John Wiley & Sons, Inc., 432 Fourth Avenue, New York City. The book covers all the present practices of modern farm-building construction, treating of the location, planning, construction, and repair of farm buildings, presenting the material in a form which makes it practicable for use as a textbook for college students, a reference for secondary schools, and a source of information for farmers, county agents, etc.

Following the introduction, barns are taken up considering in order the special types of barns for various farm animals, general purpose barn and barn equipment, followed by essentials and classifications of barns, and the construction, framing, and ventilation of this class of buildings. Hog and poultry houses, buildings for grain storage, silos, implement and machine shelters, icehouses and other minor buildings are taken up in order. Chapters are devoted to the development, planning and construction of the farm house, and its equipment, as well as a chapter on the tenant house. The important matter of farmstead planning is given a chapter, followed by individual treatment of the various building materials, building codes and fire prevention, chapters on contracts and specifications, cost estimating, plan drawing, rafter framing and cutting, weights, measures and formulas, and a reference table for farm building designs. The book consists of 377 pages, and is abundantly illustrated both with halftone reproductions of photographs and with drawings. The price is $3.

LAND DRAINAGE, by W. L. Powers, chief in soils, Oregon Agricultural College and Experiment Station; Secretary Oregon State Drainage Association 1915-1920, Member A. S. A. E; and T. A. H. Teeter, formerly professor of drainage and irrigation engineering, Oregon Agricultural College, Member American Association of Engineers. This is one of the Wiley agricultural engineering series edited by J. B. Davidson and published by John Wiley & Sons, Inc., New York City. It deals with the subject of drainage primarily from the agricultural standpoint, and the subject has been developed largely as a matter of applied soil-physics. Drainage is considered as a means of reclaiming additional areas and of making wet land more productive. The volume is intended, first, as a textbook for students of general agriculture or agricultural engineering; second, as a reference book for practical farmers; and, third, as an aid to owners of wet, overflowed, marsh, swamp, or alkaline land who desire to improve their holdings. The information presented was gathered by the authors in the corn-belt states and in the west where preliminary feasibility surveys and selection of land for irrigation projects or drainage projects were an important feature of their work. The book embodies review questions, general references and laboratory exercises.

The treatment is under four main heads, namely, field drainage, district drainage, special drainage problems, and drainage surveying.

EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

The Secretary receives at frequent intervals bulletins from the Engineering Societies' Service Bureau, 29 West 39th Street, New York City, listing the "positions open" as reported by member societies. Copies of these bulletins are sent to the "men available" listed below, as soon as received.

Men Available

AGRICULTURAL ENGINEER wants position as experimental agricultural engineer or with some agricultural publication. Graduate, 1918, agricultural college of the University of Illinois. Was editor of the Illinois agricultural students publication in his senior year. For two years employed by an explosives manufacturer as agricultural sales and service man for the State of Wisconsin. At present associated with the land clearing department of the University of Wisconsin. Age 25, married, American. MA-101

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915, five years practical experience on Illinois farm with power equipment, two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduate in mechanical engineering at Michigan Agricultural College, desires position teaching all kinds of farm machinery or automotive work, or with some farm-equipment manufacturer. Will be available April 1, 1922. Has served one year as instructor in tractors and trucks, and one year conducting service schools for a leading tractor manufacturer. Can furnish best of references. MA-110

AGRICULTURAL ENGINEER, graduate of Iowa State College 1920, with several years of practical experience farming with machinery and one year's teaching experience in high school, wants employment on a large farm or in college teaching of power farming. Twenty-five years of age. Married. MA-111

AGRICULTURAL ENGINEER wants position as demonstrator of farm machinery or building equipment, or executive position on agricultural engineering project; or conducting field tests. Accustomed to handling men and dealing with farmers and farm problems. Prefers northern location. MA-113.

CIVIL ENGINEER, graduate of University of California, with major in irrigation, formerly assistant engineer of Idaho Irrigation Company, in connection with canal enlargement, betterment, etc., and more recently associate professor of agricultural engineering at the University of Idaho in charge of irrigation, drainage, farm surveying, etc., desires position in civil engineering, in land reclamation, or teaching. Age 31. Married. Two children. MA-114.

AGRICULTURAL ENGINEER, graduating from University of Missouri at the end of present semester (available January 1, 1923), would like position teaching agricultural engineering work or with some company manufacturing farm equipment. Age 23. Unmarried. MA-115